

14.—Notes on the Regeneration of Vegetation of Garden Island after the 1956 Fire

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Manuscript accepted—27th June, 1958

Garden Island has been visited at intervals over two years since the fire at the end of January, 1956, and photographs taken and specimens collected of the regenerating vegetation. The *Acacia rostelifera* scrub, the major community of the island, is regenerating well from root suckers. The tree species, *Callitris robusta* and *Melaleuca pubescens*, are both killed by fire but are regenerating from seed. *Melaleuca* after two years' growth is both taller and in denser stands than the *Callitris*. Seedlings of the subordinate shrub species such as *Spyridium globulosum* are still less than one foot high. In the second year after the fire the most conspicuous plant in the burnt areas was the semi-herbaceous, quick growing, relatively short lived plant, *Solanum simile*, but by the end of the second summer this was waning and being overtopped by the regenerating *Acacia*. Since the fire the ground has been exposed to leaching by the heavy battering winter rains, and to sun and wind: conditions very different from those of the unburnt scrub where the soil is in heavy shade and doubly protected by the dense canopy of the shrubs and the deep litter on the surface. It will be many years before the vegetation regains its former height and density and the organic matter of the soil is restored. Observations on the regeneration will be continued.

Introduction

The vegetation and soils of Garden Island, lying off the coast of Western Australia, near Fremantle, Western Australia, were observed by McArthur in 1952 (McArthur 1957).

At the end of January, 1956, a devastating fire swept through the island destroying the vegetation of practically the whole central region—probably of the order of two-thirds of the total area. The region south of the settlement escaped, part of the northern end and small patches along both eastern and western shores. This destruction of such an area of virgin scrub represents a botanical disaster as there is little such vegetation remaining in its more or less natural state. Coastal areas on the opposite

mainland which once had similar vegetation have been drastically changed and depauperised by clearing, grazing, frequent fires and the invasion of weeds; and the neighbouring island, Rottneest, has only fragments remaining of its original vegetation cover.

The records on which this paper is based were made on a few trips with only three to four hours on the island; hence there is no claim to a thorough study of the regeneration but failing more detailed work there is justification for publishing this incomplete survey. Many photographs in both kodachrome and black and white were taken and specimens collected of the regenerating plants. These are housed in the Botany Department, University of Western Australia.

The areas visited were along the path cutting across the island from the settlement on the east to the west coast, and between the settlement and a point half a mile north of Colpoys Point (see Fig. 1). Although this represents only a small part of the area the main vegetation types are covered. From east to west the track passes through mixed scrub—*Acacia rostelifera*, *Melaleuca huegelii* and *M. pubescens* with *Spyridium globulosum* merging into a broad zone of tall dense *Acacia rostelifera* scrub which, as the dune areas of the west coast are approached, becomes much lower (Plate I, 2) and contains an admixture of dune species. The dense canopy of this scrub before the fire is shown in Plate I, 1, and a fragment in profile in Plate I, 4.

Along Careening Bay there is again *Acacia* and mixed scrub. At the Point, and scattered through the mixed *M. huegelii* and *Acacia* scrubs of the Colpoys Peninsular there are tall stands of *Melaleuca pubescens* - *Callitris robusta* (Plate II, 3). Some small patches near the shore escaped destruction in the fire, and others were killed without the tops being actually consumed by

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PLATE I.

- No. 1.—Photograph taken before the fire looking north to dense *Acacia* scrub on the far side of the east-west path which is indicated by the diagonal line across the picture. May, 1955.
- No. 2.—The low western edge of the *Acacia* scrub where it merges into the dunes. *Senecio laetus* in flower on both burnt and unburnt sides of the path. November, 1956.
- No. 3.—A stand of tall *Acacia* where regeneration was practically non-existent. November, 1956.
- No. 4.—Looking from a burnt into an unburnt part of *Acacia* scrub showing the dense tangle of stems—some regrowth in foreground. April, 1958.
- No. 5.—Regrowth from the base of an old *Leucopogon richii* plant, regeneration otherwise very poor. November, 1956.
- No. 6.—An area of very good *Acacia* regrowth.
- No. 7.—An eroded slope with horizontal roots of *Acacia* exposed. A few *Acacia* shoots and small seedlings of *Melaleuca*. November, 1956.
- No. 8.—A vigorous clump of *Acacia* suckers (upper left), *Thomasia* and *Stipa*. November, 1956.
- No. 9.—An area of good *Acacia* regrowth more than two years after the fire. April, 1958.

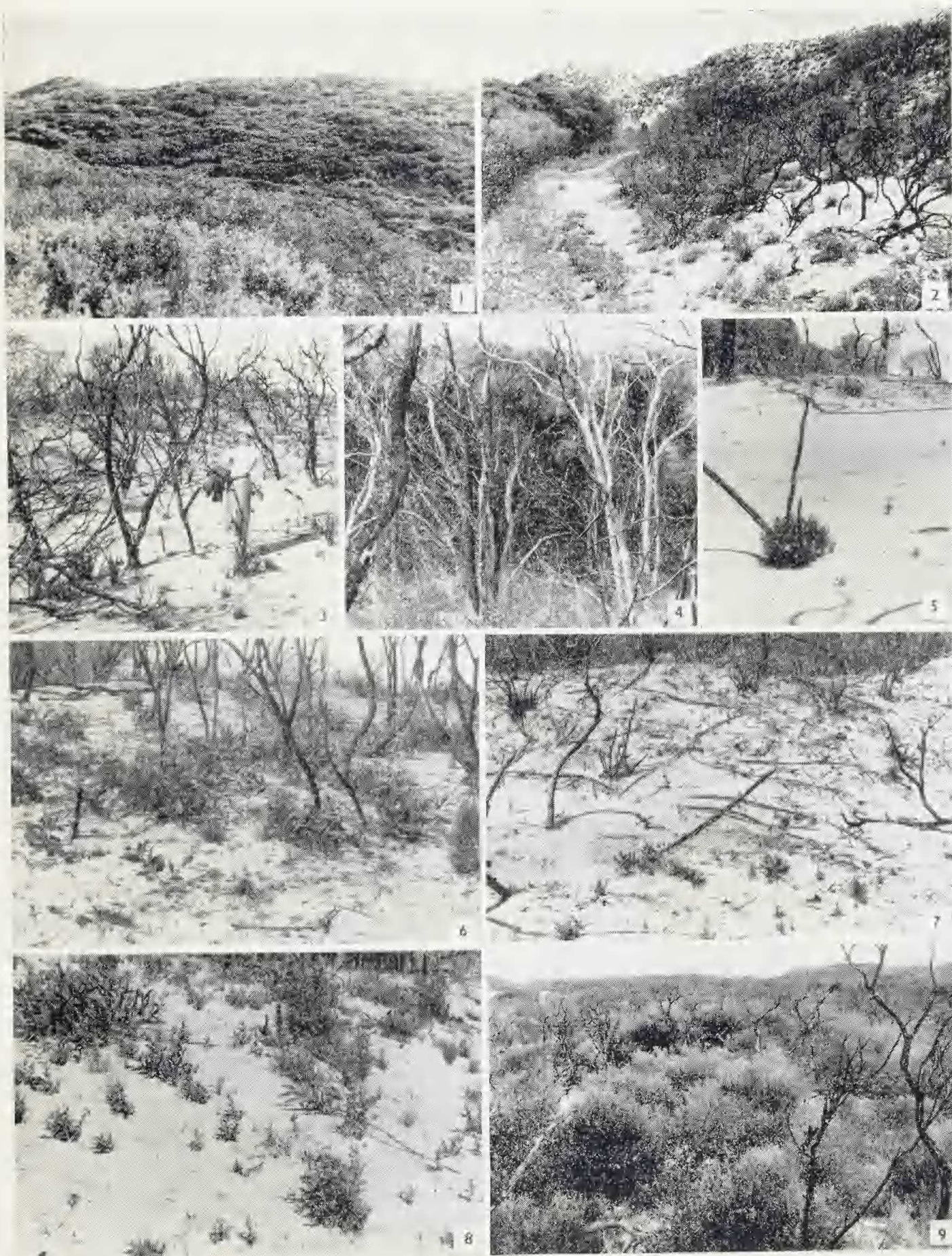


PLATE I.



PLATE II.
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fire; but the stands further inland were drastically burnt, the whole of the upper canopy being burnt off leaving a forest of bare sticks (Plate II, 5).

Regeneration

November-December, 1956.—The island was first visited in mid November, 1956, ten months after the fire, and then again early in December, i.e., after a complete winter and spring following the fire. The scene was still one of devastation

with blackened dead stems and extensive areas of bare white or grey sand. Regeneration was, however, well started. In the *Acacia* scrub there was some very good regrowth particularly on the fringes of the dense thickets and in the more open areas, with clumps of suckers up to a foot long, from roots either close to the parent plant or several feet away. Plate I, 6 shows an area of good regrowth and Plate I, 3 a poor one. No *Acacia* seedlings were seen in the heavy *Acacia* scrub but they were common in the more open areas of mixed scrub near the settlement and along the edge of Careening Bay. The heat must have been so intense in the dense scrub that any seed present had been destroyed. Seedlings of shrub species which normally occur scattered through the *Acacia* scrub, e.g. *Spyridium globulosum*, *Eremophila glabra*, were present in small numbers, being mostly about 1-3 inches high. The roots of all the seedlings were very much longer than the tops—usually exceeding 1 foot on seedlings only 2-3 inches high.

In the mixed scrub, small seedlings of the associated tree species, *Melaleuca huegelii* and *M. pubescens* were numerous in the immediate localities of parent trees (some are visible but not easily identifiable in Plate 1, 7). Of the smaller shrubs *Phyllanthus* was regenerating from seed, but no regrowth was seen. *Thomasia* seedlings were very abundant in places with a few *Guichenotia* seedlings. The quick growing semi-herbaceous plant, *Solanum simile* was flourishing particularly in sheltered hollows but was widely distributed through all the burnt areas.

Herbaceous plants were unevenly distributed. *Senecio lautus*, in flower, covered the ground in places, being more abundant towards the sand dunes on the west side, and flowering equally well on burnt and unburnt sides of the track (Plate I, 2). *Didiscus cyanoptalus* a small herb, was abundant and widespread—in flower in November and in fruit in December, and also—but in smaller numbers — *Poranthera microphylla*. *Didiscus coeruleus* the "Rottnest Daisy" was seen in local patches only, (Plate II, 2). A small species of *Crassula* was concentrated in shallow depressions and around dead bushes. The dark patch between the *Solanum* plants in Plate II, 1 consists of closely packed *Crassula* plants. It appeared that seed had been washed into the hollows or against obstructions. This applied

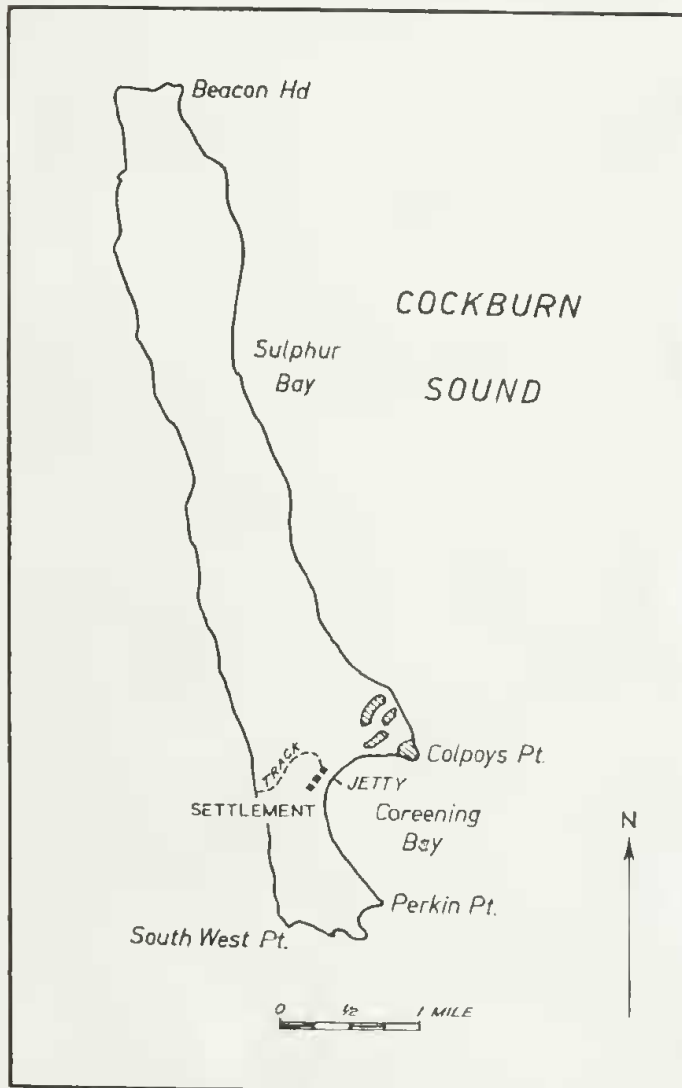


Fig. 1.—Map of Garden Island.

PLATE II.

- No. 1.—A depression in mixed scrub showing accumulation of ash washed into the hollow; *Solanum* plants with a dark mass of *Crassula* between them, scattered *Didiscus*, *Stipa* and *Melaleuca* seedlings. December 2nd, 1956.
- No. 2.—An adjacent elevation, burnt *Melaleuca huegelii*, (overhanging branch to left) burnt *Callitris* tree (right), *Didiscus coeruleus* in flower (left), also other small annuals and seedlings of various species. December 2nd, 1956.
- No. 3.—A stand of *Melaleuca-Callitris* which escaped the fire, showing the closed canopy and close spacing of tree trunks.
- No. 4.—Interior of another small stand showing the thick carpet of litter.
- No. 5.—A burnt stand of *Callitris-Melaleuca*, 10 months after the fire. Small seedlings of both species distributed sparsely over the bare stand. December, 1956.
- No. 6.—Part of the same stand 16 months later. Young plants of *Callitris* (left) and *Melaleuca* (right of white trunk). April, 1958.
- No. 7.—Another part of the stand with young plants of *Callitris* (back left), *M. huegelii* (in front of white stem), *M. pubescens* (extreme right) and *Didiscus cyanoptalus* the small annual on the shadow in the left foreground, *Solanum* through trees in the background. November 1st, 1957.
- No. 8.—An area near the Beach. A dead *Callitris* tree, *Acacia* regrowth in centre foreground and a large plant of *Solanum simile* on the extreme right. November 1st, 1957.
- No. 9.—A dense clump of young *Melaleuca pubescens*. The tallest plant in the background is *Solanum*. April, 1958.

also to other species—slopes where there had been obvious erosion were noticeably bare of annual plants and seedlings.

In the mixed *Acacia-Melaleuca* scrub along Careening Bay and beyond Colpoys Point similar regeneration was occurring. *Acacia* suckers were growing but also many seedlings, showing the compound leaves characteristic of the seedling stage. *Acanthocarpus* and *Stipa* were regenerating from old plants. *Leucopogon richii*, a woody shrub scattered sparsely through the area, showed vigorous regrowth from the base of the plant (Plate I, 5).

Erosion was evident where the ground sloped. Plate I, 8 shows horizontal roots of *Acacia rostellifera* exposed where sand had been washed away. There were some very bare slopes down into the hollows behind the dune fringe and evidence of accumulation of ash and charcoal in some of the hollows (Plate II, 1). The hills in the centre were not visited, but from the sea these appeared to be much barer of vegetation than the flats below. It is not unreasonable to suppose that these higher slopes suffered erosion of both soil and seed.

The mobile dune vegetation is no different from that along the mainland beaches and little time was devoted to the examination of it. The principal cover plants, *Olearia axillaris* and *Scaevola crassifolia* had been killed by fire. Seedlings were present but were still very small in December, 1956. The sedges, *Lepidosperma gladiatum* and *Scirpus nodosus* were regenerating from the underground rhizomes.

In the *Callitris-Melaleuca* forests the regeneration was from seed and the seedlings were still, after a full winter and spring growth, only from 1-4 inches tall. The dense stand of *Callitris* (Plate II, 5) is one of several on Colpoys Peninsula: it lies in a slight depression behind the beach sandhills. There had evidently been considerable wash of sand down the gentle slopes—the sand was bare except for the small sparsely scattered seedlings of *Melaleuca* and *Callitris*. They are difficult to see in the photograph and were not conspicuous in the field. Herbaceous plants were absent except for a small patch at the bottom of a depression. On the surrounding higher ground where the bush had been much more open, seedlings of *Solanum*, *Thomasia* and *Phyllanthus* and flowering plants of *Didiscus*, gave some conspicuous cover between the suckers of *Acacia* and the seedlings of *Melaleuca* and *Callitris*.

May, 1957.—At the beginning of the next winter, fifteen months after the fire, a very brief visit to the Colpoys Peninsula area showed that there had been considerable growth of the *Melaleuca* seedlings. There was less increase in the *Callitris* while the seedlings of the shrub, *Spyridium*, were still very small. Young plants of *Phyllanthus* which had survived were beginning to grow new shoots from stems which had been defoliated over the summer.

November 1st, 1957.—After another season's growth the general impression was of *Solanum simile* dominating the area. The more pronounced hollows and sheltered areas were occupied

by big spreading leafy bushes up to five feet tall. Less massive plants occurred among the *Acacia* suckers. *Solanum* was present through all the communities seen, except on exposed rises and the western sand dunes. The rapid growth from the seedling of this herbaceous plant was in striking contrast to the slow progress of the seedlings of the long lived, woody shrub species such as *Spyridium* and *Beyeria* which were still only a few inches high. *Acacia* suckers had made good progress up to about three feet and were still growing vigorously though obscured in places by the *Solanum*. There were bare areas as noticed the previous year where the fire had been particularly intense.

Herbaceous plants, *Senecio lautus* and *Didiscus cyanopetalus* had flowered earlier than the previous year and were in fruit. Both were abundant as in the first year after the fire. *Crassula* was still present in large numbers, also *Poranthera microphylla*. At this time these annuals were dying off.

In the mixed scrub, both along the path to the west and along Careening Bay, *Melaleuca* seedlings of both species were now plants from 1-4 feet high. *M. pubescens* was taller on the average, while *M. huegelii* was more compact and bushy (Plate II, 7). *Phyllanthus* plants about one foot tall had flowered but were now very yellow and dry. *Thomasia*, spreading plants a foot or more in diameter and about the same height, were fairly widespread. *Pelargonium* and *Carpobrotus*, seen as small seedlings the previous year, were now spreading plants. *Guichenotia* was rare, except beyond Colpoys Point where it was fairly common.

April, 1958.—Towards the end of a particularly long dry summer, the picture had changed. Whereas in October, *Solanum* had dominated the scene, in April the bushes though still alive, were yellowed and partly defoliated, while the *Acacia* regrowth from old established root systems had made considerably more growth. Though at that time growth had ceased, the leaves were still bright green, and the stems had thickened considerably since October. The *Melaleuca* seedlings had probably made some further growth and on the whole were in good condition but some had died, particularly where crowded. *Callitris* seedlings were not much bigger than when last seen, were very yellow and dry and obviously suffering water stress. Seedlings of *Spyridium* were still small. *Thomasia* plants although brown, did not appear to be dead. *Phyllanthus* which had made luxuriant growth in the first winter, and had flowered in the second, had suffered in the severe summer of 1957-8 and most of the plants seen were dead.

Discussion

The soil has not been studied. In view of the drastic change which has taken place, a study of the nutrient status of the soils on the burnt areas for comparison with McArthur's finding before the fire and a continued study of the regeneration or deterioration of the soil over the next few years seems to be highly desirable. It is unfortunate that such a study was not started immediately after the fire. The writer did not see the island until after a whole rainy season,

by which time the ash from the burnt region had been washed in. From reports of eyewitnesses, and from consideration of the amount of plant material consumed, this must have been in very much greater quantity than is usual after the more frequent fires on the mainland, and must have temporarily increased the soil mineral content greatly. McArthur found a very high nitrogen level, (for West Australian soils) under the long unburnt scrub. Evidence that the nitrogen level was high after the fire was the remarkable growth of the *Phyllanthus* seedlings. This species is known to react well to nitrogen manuring. It is widespread on the mainland and seedlings are common after bush fires. In the neighbourhood of Perth where it grows in Jarrah-Banksia woodland on sandy soils seedlings usually reach a height of only 2 or 3 inches in the first year and about 6-10 inches in the second year. On Garden Island they ranged in size from a few inches to a foot high in the first year, and the leaves were at least twice the normal size. Some seedlings brought from the island and planted beside local young plants near the University have after more than a year in the poorer sand approached much more closely to the usual condition—the leaves formed recently are only about half the size of those present when the seedlings were transplanted.

Notable in the unburnt bush on Garden Island was the deep plant litter and high organic content of the surface layers of soil. A year after the fire the soil was still bare and white, with only a small proportion of the surface covered by vegetation. After two years, although there has been regeneration as described, much of the soil surface is still exposed to sun and rain, and the amount of plant debris which has accumulated is extremely small. It seems that it will be many years—even assuming there are no further fires—before either the vegetation or the soil regains its former condition. The *Acacia* scrub suckering from the old plants will build up more quickly than the *Melaleuca* and *Callitris*. The *Acacia* is at present moving into the margins of the stands of *Callitris* and *Melaleuca*. No doubt the position could be reversed in time if the *Melaleuca* reaches tree size and overshadows the *Acacia*. McArthur (1957, p. 52) found evidence that the *Callitris* stands had been extending their range before the fire. At present the 2-year old *Melaleuca* plants are both taller and broader and more closely spaced than the *Callitris* ones, but in the stands seen there is so far little competition between them. Evidence from the former communities is that the two species grow happily together in dense stands

both forming slender trunks and with similar canopies at the same level; this despite the very different shapes of isolated trees.

The regeneration of vegetation on Garden Island forms a striking contrast to that on Rott-nest which was also devastated by fire a year earlier. Here regeneration of both *Acacia* and *Melaleuca* was effectively prevented by grazing by the quokka (*Setonix brachyurus*). As *Solanum* is not eaten it was abundant on Rott-nest as on Garden Island. Any effect of grazing of the regrowth by the Garden Island Wallaby (*Protemnodon eugenii*) was too slight to be noticed by the author in the brief visits. The small population of animals puts no pressure on the large areas of *Acacia* scrub. The only plants noted as having been cropped to ground level were one or two tufts of *Carex*, but very little of this plant was seen.

A feature of the reaction to fire of the coastal vegetation of the type found on Garden Island, but not peculiar to the islands, is the relatively small number of species capable of regenerating from underground parts, whereas in the typical mainland communities only a small percentage of the total species are killed by fire, and recovery of the bush is in consequence much more rapid. The list below shows behaviour of the commoner shrub species in this respect.

Species which sprouted from underground parts

Acacia rostellifera Benth.
Leucopogon richii (Labill.) R.Br.
Clematis microphylla D.C.
Lepidosperma gladiatum Labill.
Scirpus nodosus Rottb.
Stipa variabilis Hughes.
Acanthocarpus preissii Lehm.

Species which regenerated from seed only

Melaleuca pubescens Schau.
M. huegelii Endl.
Phyllanthus calycinus Labill.
Thomasia cognata Steud.
Guichenotia ledifolia J. Gray.
Beyeria viscosa (Labill.) Miq.
Spyridium globulosum (Labill.) Benth.
Boronia alata Smith.
Scaevola crassifolia Labill.
Olearia axillaris (D.C.) F.v.M.
Carpobrotus aequilaterus N.E. Br.

Reference

McArthur, W. M. (1957).—Plant Ecology of the coastal islands near Fremantle, W.A. *J. Roy. Soc. W. Aust.* 40: 46-64.